

## HX40N120-TO264 1200V NPT IGBT

### General Description

The HX40N120-TO264 AND series of IGBTs, leveraging Non-Punch-Through (NPT) technology, boasts low conduction and switching losses, making it an ideal solution for various applications including induction heating (IH), motor control systems, general-purpose inverters, as well as uninterruptible power supplies (UPS).

### Features

- High speed switching
- Low saturation voltage :  $V_{CE(sat)} = 2.6\text{ V}$  @  $I_C = 40\text{ A}$
- High input impedance
- CO-PAK, IGBT with FRD :  $t_{rr} = 75\text{ ns}$  (typ.)

### Absolute Maximum Ratings

| Symbol      | Parameter                                                                                                   | HX40N120-TO264 | Units            |
|-------------|-------------------------------------------------------------------------------------------------------------|----------------|------------------|
| $V_{CES}$   | Collector-Emitter Voltage                                                                                   | 1200           | V                |
| $V_{GES}$   | Gate-Emitter Voltage                                                                                        | $\pm 25$       | V                |
| $I_C$       | Collector Current @ $T_C = 25^\circ\text{C}$                                                                | 64             | A                |
|             | Collector Current @ $T_C = 100^\circ\text{C}$                                                               | 40             | A                |
| $I_{CM(1)}$ | Pulsed Collector Current                                                                                    | 160            | A                |
| $I_F$       | Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$                                                | 40             | A                |
| $I_{FM}$    | Diode Maximum Forward Current                                                                               | 240            | A                |
| $P_D$       | Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$                                                        | 500            | W                |
|             | Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$                                                       | 200            | W                |
| $SCWT$      | Short Circuit Withstand Time,<br>$V_{CE} = 600\text{V}$ , $V_{GE} = 15\text{V}$ , $T_C = 125^\circ\text{C}$ | 10             | $\mu\text{s}$    |
| $T_J$       | Operating Junction Temperature                                                                              | -55 to +150    | $^\circ\text{C}$ |
| $T_{STG}$   | Storage Temperature Range                                                                                   | -55 to +150    | $^\circ\text{C}$ |
| $T_L$       | Maximum Lead Temp. for Soldering<br>Purposes, 1/8" from Case for 5 seconds                                  | 300            | $^\circ\text{C}$ |

### Thermal Characteristics

| Symbol                        | Parameter                               | Typ. | Max. | Units              |
|-------------------------------|-----------------------------------------|------|------|--------------------|
| $R_{\theta JC}(\text{IGBT})$  | Thermal Resistance, Junction-to-Case    | --   | 0.25 | $^\circ\text{C/W}$ |
| $R_{\theta JC}(\text{DIODE})$ | Thermal Resistance, Junction-to-Case    | --   | 0.7  | $^\circ\text{C/W}$ |
| $R_{\theta JA}$               | Thermal Resistance, Junction-to-Ambient | --   | 25   | $^\circ\text{C/W}$ |

## Electrical Characteristics of the IGBT T<sub>c</sub> = 25°C unless otherwise noted

| Symbol                             | Parameter                                    | Conditions                                                                                                                        | Min. | Typ. | Max. | Units |
|------------------------------------|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|------|------|------|-------|
| Off Characteristics                |                                              |                                                                                                                                   |      |      |      |       |
| BV <sub>CES</sub>                  | Collector-Emitter Breakdown Voltage          | V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA                                                                                        | 1200 | --   | --   | V     |
| BV <sub>CES</sub> /ΔT <sub>J</sub> | Temperature Coefficient of Breakdown Voltage | V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA                                                                                        | --   | 0.6  | --   | V/°C  |
| I <sub>CES</sub>                   | Collector Cut-Off Current                    | V <sub>CE</sub> = V <sub>CES</sub> , V <sub>GE</sub> = 0V                                                                         | --   | --   | 1    | mA    |
| I <sub>GES</sub>                   | G-E Leakage Current                          | V <sub>GE</sub> = V <sub>GES</sub> , V <sub>CE</sub> = 0V                                                                         | --   | --   | ±250 | nA    |
| On Characteristics                 |                                              |                                                                                                                                   |      |      |      |       |
| V <sub>GE(th)</sub>                | G-E Threshold Voltage                        | I <sub>C</sub> = 250μA, V <sub>CE</sub> = V <sub>GE</sub>                                                                         | 3.5  | 5.5  | 7.5  | V     |
| V <sub>CE(sat)</sub>               | Collector to Emitter Saturation Voltage      | I <sub>C</sub> = 40A, V <sub>GE</sub> = 15V                                                                                       | --   | 2.6  | 3.2  | V     |
|                                    |                                              | I <sub>C</sub> = 40A, V <sub>GE</sub> = 15V, T <sub>C</sub> = 125° C                                                              | --   | 2.9  | --   | V     |
|                                    |                                              | I <sub>C</sub> = 64A, V <sub>GE</sub> = 15V                                                                                       | --   | 3.15 | --   | V     |
|                                    |                                              |                                                                                                                                   |      |      |      |       |
| Dynamic Characteristics            |                                              |                                                                                                                                   |      |      |      |       |
| C <sub>ies</sub>                   | Input Capacitance                            | V <sub>CE</sub> = 30V, V <sub>GE</sub> = 0V f = 1MHz                                                                              | --   | 3200 | --   | pF    |
| C <sub>oes</sub>                   | Output Capacitance                           |                                                                                                                                   | --   | 370  | --   | pF    |
| C <sub>res</sub>                   | Reverse Transfer Capacitance                 |                                                                                                                                   | --   | 125  | --   | pF    |
| Switching Characteristics          |                                              |                                                                                                                                   |      |      |      |       |
| t <sub>d(on)</sub>                 | Turn-On Delay Time                           | V <sub>CC</sub> = 600V, I <sub>C</sub> = 40A, R <sub>G</sub> = 5Ω, V <sub>GE</sub> = 15V, Inductive Load, T <sub>C</sub> = 25° C  | --   | 15   | --   | ns    |
| t <sub>r</sub>                     | Rise Time                                    |                                                                                                                                   | --   | 20   | --   | ns    |
| t <sub>d(off)</sub>                | Turn-Off Delay Time                          |                                                                                                                                   | --   | 110  | --   | ns    |
| t <sub>f</sub>                     | Fall Time                                    |                                                                                                                                   | --   | 40   | 80   | ns    |
| E <sub>on</sub>                    | Turn-On Switching Loss                       |                                                                                                                                   | --   | 2.3  | 3.45 | mJ    |
| E <sub>off</sub>                   | Turn-Off Switching Loss                      |                                                                                                                                   | --   | 1.1  | 1.65 | mJ    |
| E <sub>ts</sub>                    | Total Switching Loss                         |                                                                                                                                   | --   | 3.4  | 5.1  | mJ    |
| t <sub>d(on)</sub>                 | Turn-On Delay Time                           | V <sub>CC</sub> = 600V, I <sub>C</sub> = 40A, R <sub>G</sub> = 5Ω, V <sub>GE</sub> = 15V, Inductive Load, T <sub>C</sub> = 125° C | --   | 20   | --   | ns    |
| t <sub>r</sub>                     | Rise Time                                    |                                                                                                                                   | --   | 25   | --   | ns    |
| t <sub>d(off)</sub>                | Turn-Off Delay Time                          |                                                                                                                                   | --   | 120  | --   | ns    |
| t <sub>f</sub>                     | Fall Time                                    |                                                                                                                                   | --   | 45   | --   | ns    |
| E <sub>on</sub>                    | Turn-On Switching Loss                       |                                                                                                                                   | --   | 2.5  | --   | mJ    |
| E <sub>off</sub>                   | Turn-Off Switching Loss                      |                                                                                                                                   | --   | 1.8  | --   | mJ    |
| E <sub>ts</sub>                    | Total Switching Loss                         |                                                                                                                                   | --   | 4.3  | --   | mJ    |
| Q <sub>g</sub>                     | Total Gate charge                            | V <sub>CE</sub> = 600V, I <sub>C</sub> = 40A, V <sub>GE</sub> = 15V                                                               | --   | 220  | 330  | nC    |
| Q <sub>ge</sub>                    | Gate-Emitter Charge                          |                                                                                                                                   | --   | 25   | 38   | nC    |
| Q <sub>gc</sub>                    | Gate-Collector Charge                        |                                                                                                                                   | --   | 130  | 195  | nC    |

## Electrical Characteristics of DIODE T<sub>c</sub> = 25°C unless otherwise noted

| Symbol          | Parameter                           | Test Conditions                          |                          | Min. | Typ. | Max. | Units |
|-----------------|-------------------------------------|------------------------------------------|--------------------------|------|------|------|-------|
| V <sub>FM</sub> | Diode Forward Voltage               | I <sub>F</sub> = 40A                     | T <sub>C</sub> = 25, °C  | --   | 3.2  | 4.0  | V     |
|                 |                                     |                                          | T <sub>C</sub> = 125, °C | --   | 2.7  | --   |       |
| t <sub>rr</sub> | Diode Reverse Recovery Time         | I <sub>F</sub> = 40A,<br>di/dt = 200A/μs | T <sub>C</sub> = 25, °C  | --   | 75   | 112  | nS    |
|                 |                                     |                                          | T <sub>C</sub> = 125, °C | --   | 130  | --   |       |
| I <sub>rr</sub> | Diode Peak Reverse Recovery Current |                                          | T <sub>C</sub> = 25, °C  | --   | 8    | 12   | A     |
|                 |                                     |                                          | T <sub>C</sub> = 125, °C | --   | 13   | --   |       |
| Q <sub>rr</sub> | Diode Reverse Recovery Charge       |                                          | T <sub>C</sub> = 25, °C  | --   | 300  | 450  | nC    |
|                 |                                     |                                          | T <sub>C</sub> = 125, °C | --   | 845  | --   |       |

## Typical Performance Characteristics

Figure 1. Typical Output Characteristics

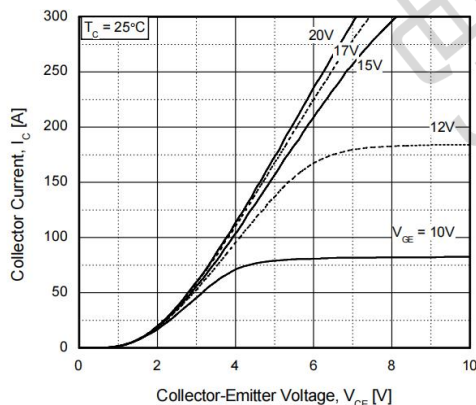


Figure 2. Typical Saturation Voltage Characteristics

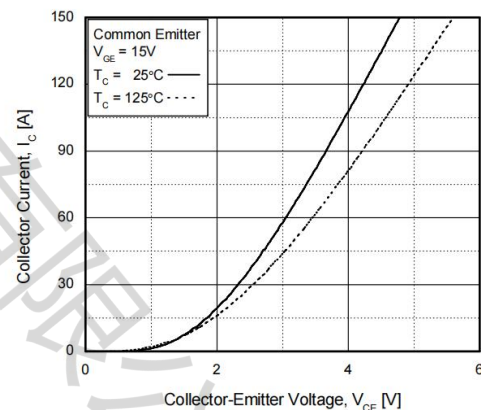


Figure 3. Saturation Voltage vs. Case Temperature at Variant Current Level

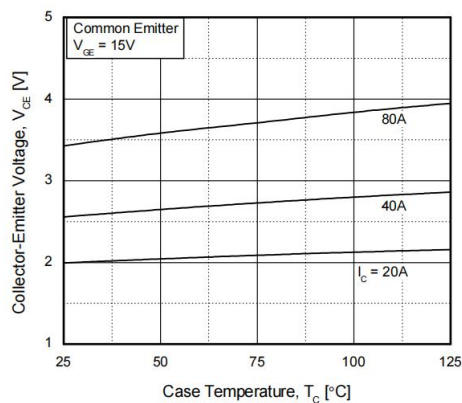


Figure 4. Load Current vs. Frequency

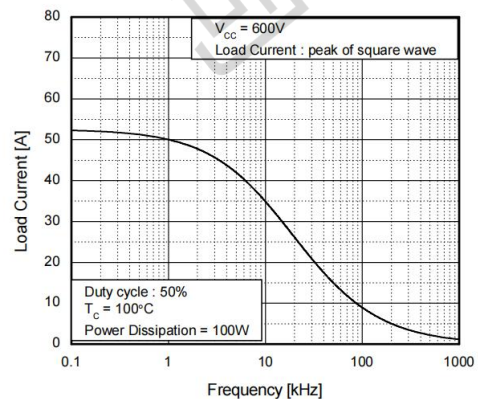


Figure 5. Saturation Voltage vs.  $V_{GE}$

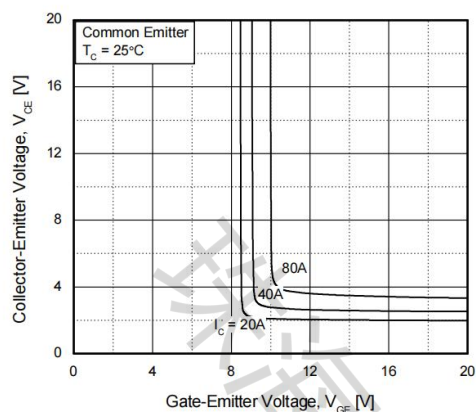


Figure 6. Saturation Voltage vs.  $V_{GE}$

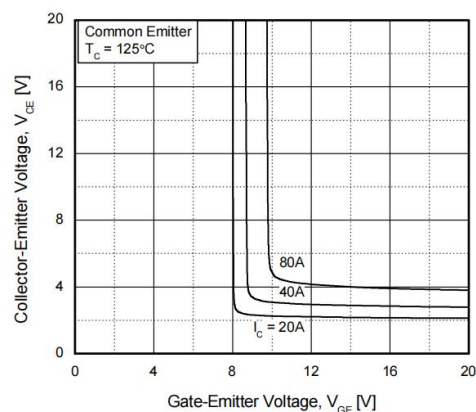


Figure 7. Capacitance Characteristics

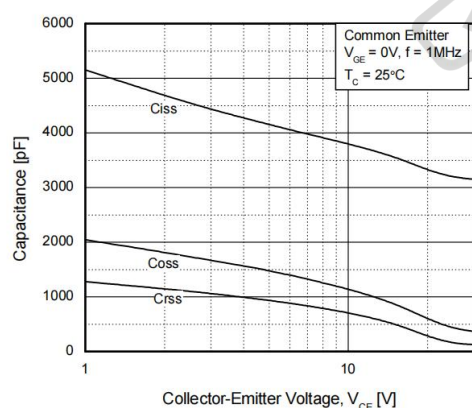


Figure 8. Turn-On Characteristics vs. Gate Resistance

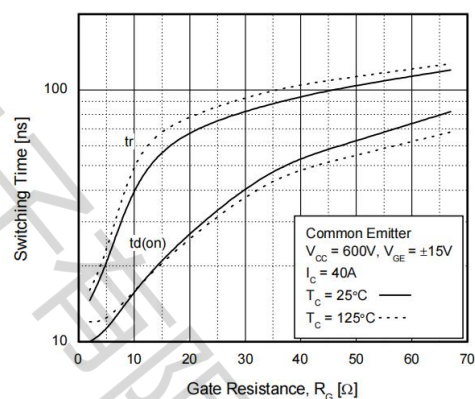


Figure 9. Turn-Off Characteristics vs. Gate Resistance

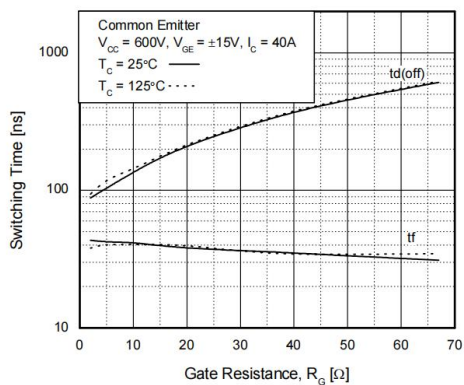


Figure 10. Switching Loss vs. Gate Resistance

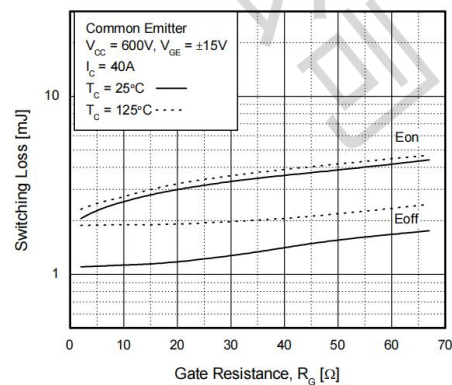


Figure 11. Turn-On Characteristics vs. Collector Current

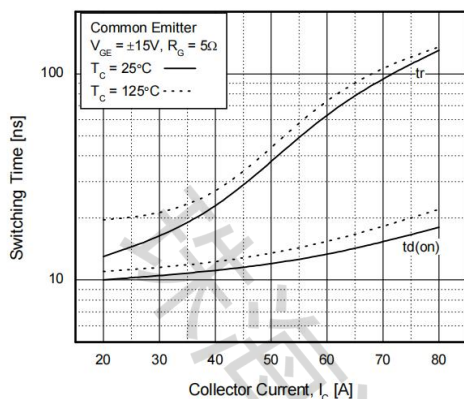


Figure 12. Turn-Off Characteristics vs. Collector Current

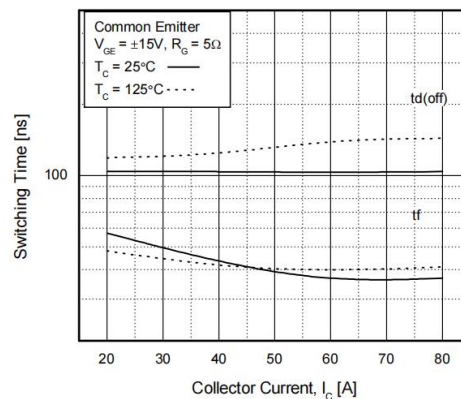


Figure 13. Switching Loss vs. Collector Current

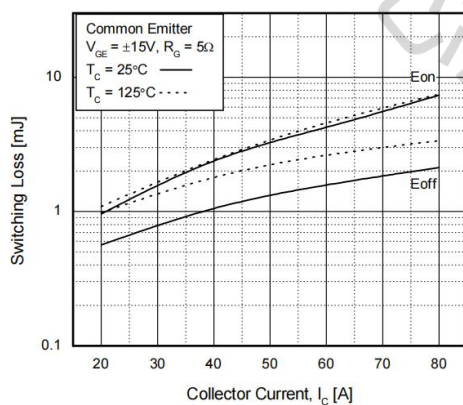


Figure 14. Gate Charge Characteristics

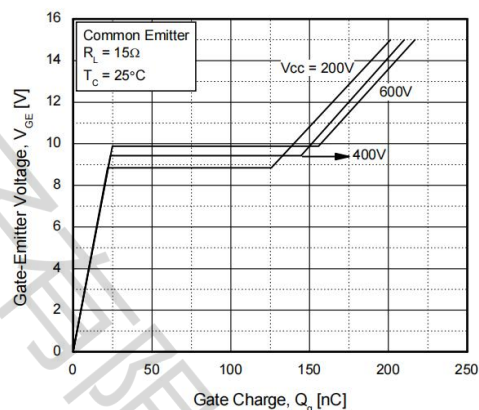


Figure 15. SOA Characteristics

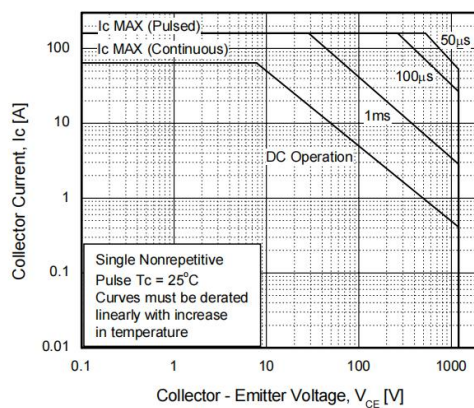


Figure 16. Turn-Off SOA

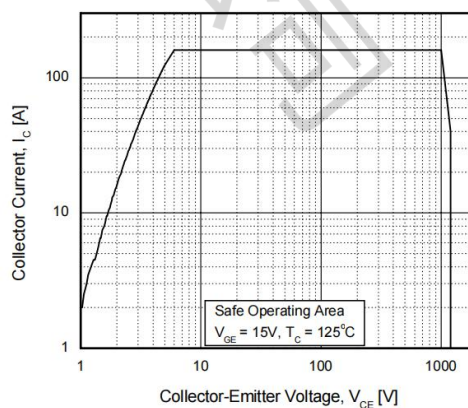


Figure 17. Forward Characteristics

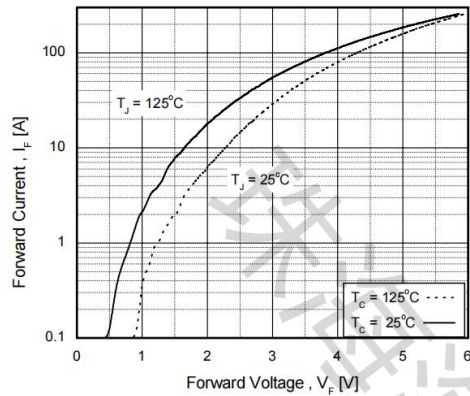


Figure 18. Reverse Recovery Current

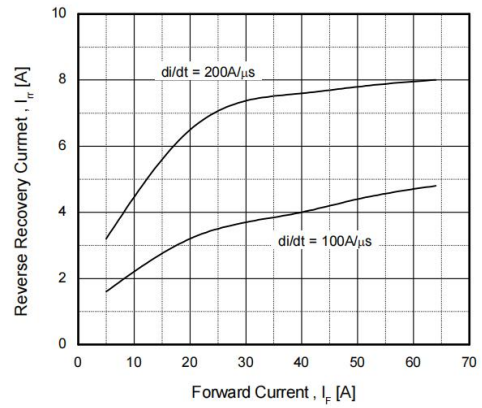


Figure 19. Stored Charge

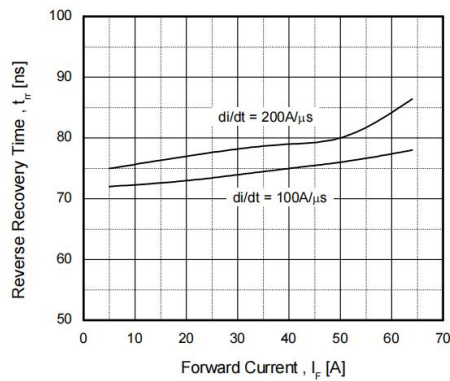


Figure 20. Reverse Recovery Time

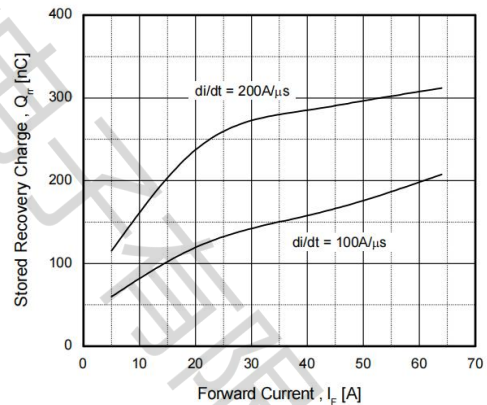
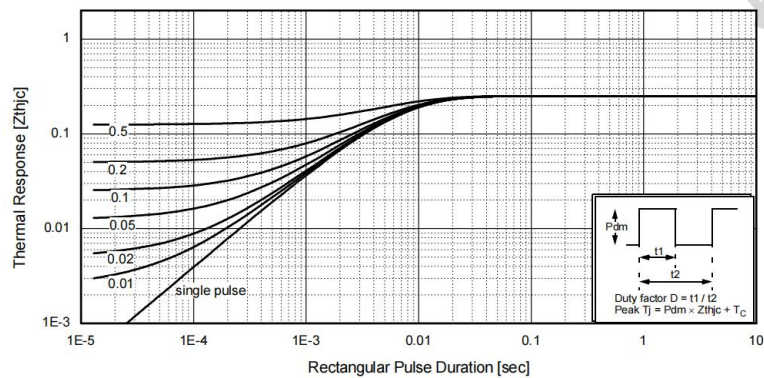
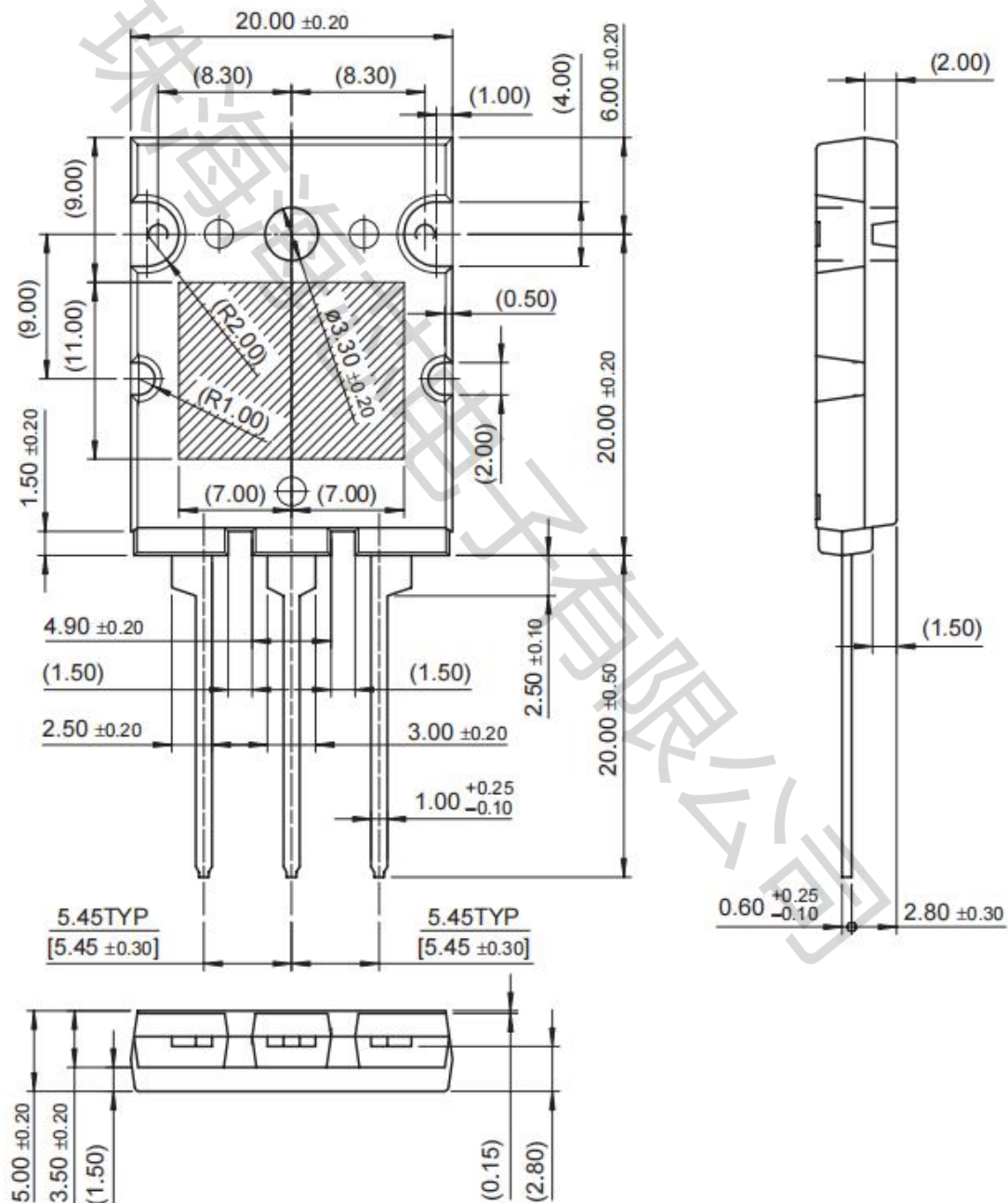


Figure 21. Transient Thermal Impedance of IGBT



**Mechanical Dimensions**

**TO-264**



| Part Number    | Package Type | Package | quantity |
|----------------|--------------|---------|----------|
| HX40N120-TO264 | TO-264       | 管装      | 25       |

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